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JULY 1974

**FLIGHT SERVICE EVALUATION
OF PRD-49/EPOXY COMPOSITE PANELS
IN WIDE-BODIED COMMERCIAL TRANSPORT AIRCRAFT**

**FIRST ANNUAL
FLIGHT SERVICE EVALUATION REPORT**

BY

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Prepared under Contract No. NAS1-11621

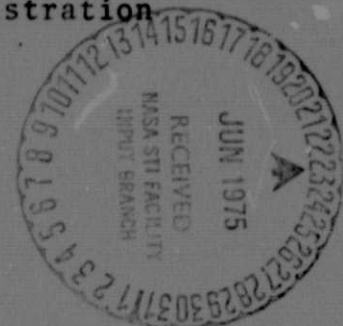
for

**Langley Research Center
National Aeronautics and Space Administration
Hampton, Virginia 23365**

by

**Lockheed-California Company
Burbank, California**

A Division of Lockheed Aircraft Corporation



(NASA-CR-132647) FLIGHT SERVICE EVALUATION
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FOREWORD

This is the first annual flight service evaluation report on the condition of PRD-49 fairing panels installed on three Lockheed L-1011's as a part of Contract No. NAS1-11621, "Flight Service Evaluation of PRD-49 Composite Panels in Wide-Bodied Commercial Transport Aircraft". The manufacture and installation of these panels was completed in February 1973 and was reported in NASA CR-112250, dated March 1973. Annual reports describing the service performance of these panels will be prepared and submitted for the next four years.

This program has been administered by the Langley Research Center, National Aeronautics and Space Administration with Mr. Benson Dexter of the Materials Division being the Project Engineer.

The program is being performed by the Lockheed-California Company under the direction of John H. Wooley. Special assistance in the flight service evaluation was provided by N. L. Seeley, R. S. Beck, D. H. Horadam and B. Woods of the Product Support Branch.

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SUMMARY

Eighteen PRD-49 (Kevlar-49)* L-1011 fairing panels were fabricated to evaluate the fabrication characteristics and flight service performance of this new composite reinforcing material and to compare it with the fiberglass which is currently used in these parts. Three panel configurations were selected to evaluate the PRD-49 with two resin matrix materials [344°K (160°F) and 422°K (300°F) maximum operating environments] in sandwich and solid laminate construction. Left and right hand versions of these three configurations were installed on three L-1011's which will accumulate approximately 3000 flight hours per year per aircraft. Eastern, TWA and Air Canada L-1011's were selected to provide eastern seaboard, trans-continental and cold northern route structures. A summary of the program tasks is presented in Figure I.

The direct substitution of PRD-49 for fiberglass produced a twenty-six percent weight reduction on the three panel configurations being evaluated. Other results of the fabrication and installation phases of the program are presented in NASA report CR-112250, dated March 1973.

* Du Pont has designated the PRD-49 fiber, Kevlar-49

After approximately one year of operation, Eastern Airlines has accumulated 3539 hours and 1722 flights; TWA 2404 hours and 1037 flights and Air Canada 2360 hours and 1470 flights on their aircraft. Examination of these panels revealed that there was no visible difference between the PRD-49 and adjacent fiberglass panels. There were some minor nicks, indentations and elongation of holes in the panels, but similar damage was also evident on the fiberglass panels.

All three panel configurations are continuously exposed to phosphate ester hydraulic fluid, such as Skydrol or Aerosafe 2300. This fluid will attack many organic materials and acts as an excellent paint stripper on certain paints, but it had no apparent effect on the PRD-49 panels. The extensive exposure to this fluid was not anticipated as one of the environments that would be encountered; however, prior accelerated tests have demonstrated that both the resin matrix and PRD-49 fiber are resistant to these fluids.

As the result of a fire in the TWA aircraft in April 1974, the subject panels were removed and will be installed on a new TWA L-1011 to be delivered in December 1974.

INSPECTION RESULTS

The flight service evaluation of this program consists of annual inspections of the PRD-49 fairings. This will normally be accomplished during a major inspection of each of the three aircraft. The participating airlines and Lockheed Product Support personnel have also been instructed to report any damage and repair that might occur in the interim.

Detail observations on each of the panels during the first annual inspection are described below. On all three aircraft, each of the panels was covered with a film of phosphate ester hydraulic oil, but there was no evidence of any deterioration from the fluid.

Air Canada Aircraft No. CF-TNB-502

Inspection of the Air Canada aircraft was conducted in April 1974, while it was at the Lockheed Burbank plant for modification. There had been 2360 flight hours and 1470 flights accumulated on the aircraft at the time.

Wing-to-Body Fairing Panel

There were some minor indentations on the exterior surface of the panels, but similar damage was also observed on adjacent fiberglass panels. In one instance there was a 2.54 centimeter (one inch) crack in the exterior skin of the left panel as shown in Figure II. Minor repair will be required to cover the hole.

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The panel on the left side was removed for closer examination. Thorough tapping of both the interior and exterior surfaces produced no evidence of delamination and there was no damage to the fastener holes. A weight check showed no discernible change in the panel weight after the year of operation.

Wing-Body Fillet Panel

A few attachments were removed from the panels and the fastener holes that were observed were in good condition. Figure III shows the right hand panel installed on the aircraft.

Center Engine Fairing Panel

Some paint had been removed from the exterior surface of the right hand panel as shown in Figure IV. Therefore, it was decided to remove the panel for closer examination. The paint topcoat and primer were not adhering to the flame sprayed aluminum surface. A few fiberglass panels also have had paint adhesion problems which have been traced to inadequate release agent removal. Since these panels contained the elevated temperature resistant resin, they had to be cured at a higher temperature which creates some difficulty in getting the flame spray coating to release from the tool. However, this problem has been resolved on subsequent production lots. All loose paint was removed and the panel was repainted prior to re-installation.

It was also observed that a single ply of fabric had been bonded to both ends of the panel as shown in Figure V. However, there is no record of this rework at either the Lockheed or Air Canada facilities. The repair material used and the time of its application are still unknown.

Some elongation of the holes was observed in a few areas on the panel, but the condition was not serious enough to warrant repair.

Eastern Airlines Aircraft No. N314EA

The PRD-49 panels were examined on the aircraft by Lockheed and Eastern personnel during a regular scheduled inspection at Eastern Airlines' Miami facility. After one year and four months of operation, the aircraft had accumulated 3539 flight hours and 1722 flights. There was no indication of any damage or any difference between the PRD-49 and fiberglass panels.

Trans World Airlines Aircraft No. N31-007

As the result of a fire in this aircraft in April 1974, the panels were removed and returned to the Lockheed-California Company for re-installation on a new TWA L-1011 to be delivered in December 1974. There was no damage to the panels from the fire; however, other minor damage was found as described below. The panels experienced 2404 flight hours and 1037 flights during the first year.

Wing-to-Body Fairing

These panels were in excellent condition when received at Lockheed with the exception of a very small indentation and a crack in the right hand panel. The crack in the exterior surface is being repaired by covering it with two plies of glass cloth impregnated with an epoxy resin consisting of Epon* 812, Epon* 828, Versamid** 115 and Versamid** 125. This resin cures for one hour at 355°K (180°F) or 12 hours at 294°K (70°F).

Wing-Body Fillet Panel

The only damage to the fillets was some elongation of the holes in the right hand panel as shown in Figures VI and VII. These holes will be repaired by sanding down the frayed fibers, solvent cleaning and completely filling the holes with the abovementioned resin system containing five percent glass fibers. Elongation of fastener holes in any of these panel configurations is not peculiar to PRD-49. More severe hole damage has been witnessed on other fiberglass fillet panels.

Center Engine Fairing Panel

The panel on the right side had one ply of the fabric delaminated along the edge as shown in Figure VIII. On close examination it can be seen that a fillet of sealing compound was still adhering to the edge of the panel along the delaminated areas.

* Shell Chemical Company
** General Mills Inc.

Evidently the adhesion of the sealing compound to the laminate and metal substructure placed a peeling force on the resin matrix causing it to peel back as the panel was removed.

The delaminated ply will be bonded back together with a resin capable of withstanding the 422°K (300°F) service environment.

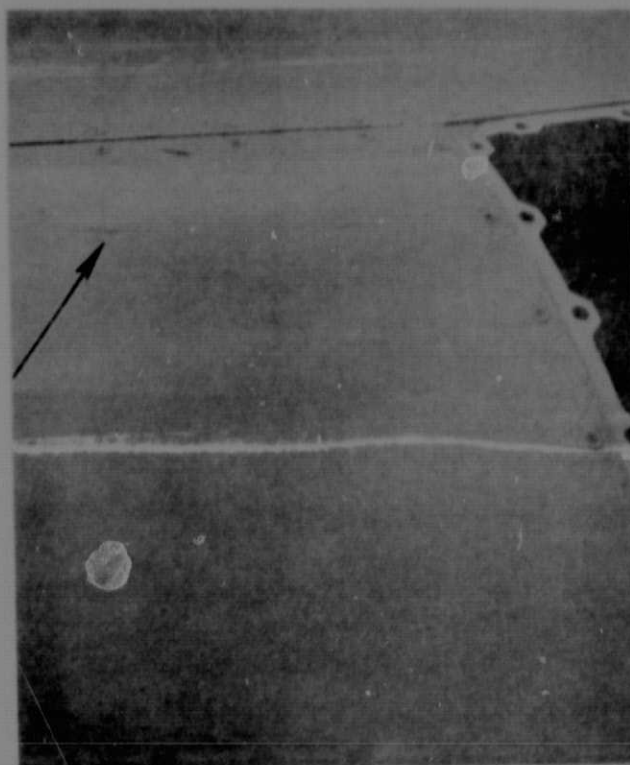


Figure II Crack in Wing-to-Body Fairing

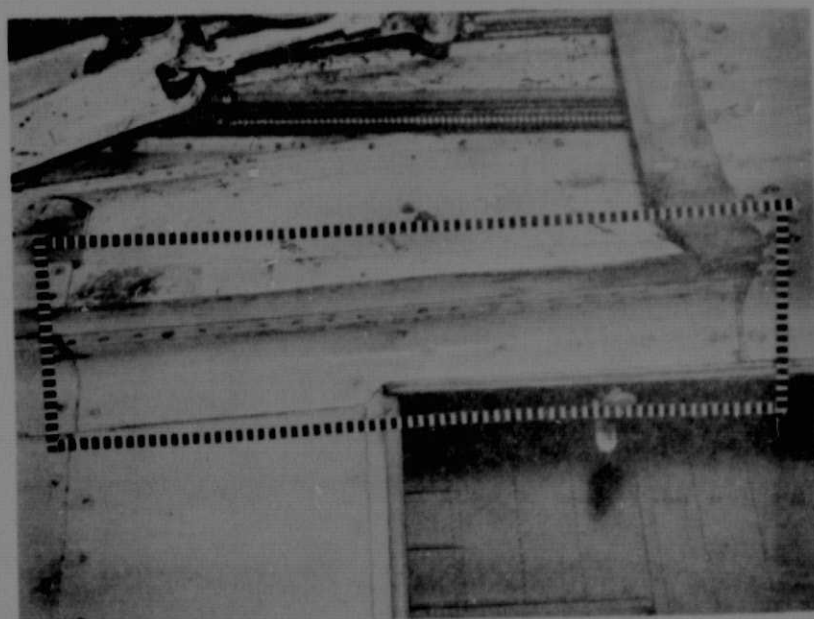


Figure III Wing-Body Fillet Installed on Aircraft

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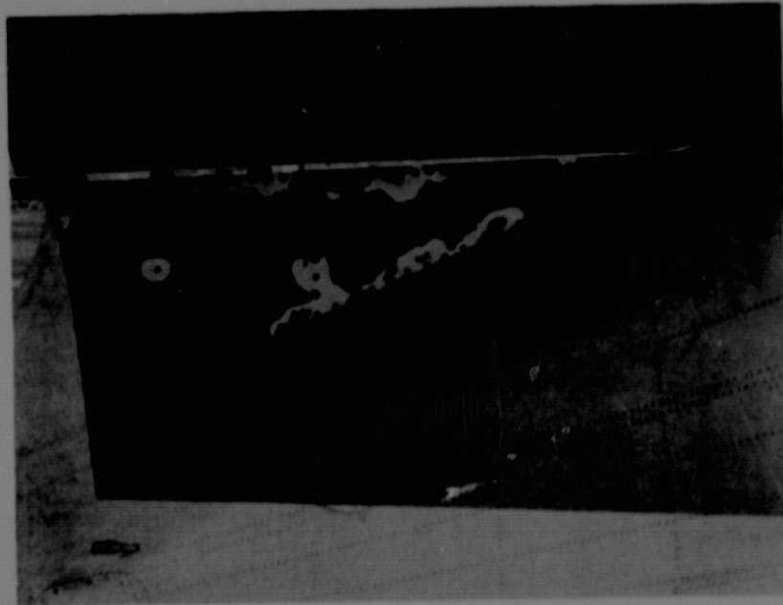


Figure IV Center Engine Fairing



Figure V Center Engine Fairing with Added Material at Ends

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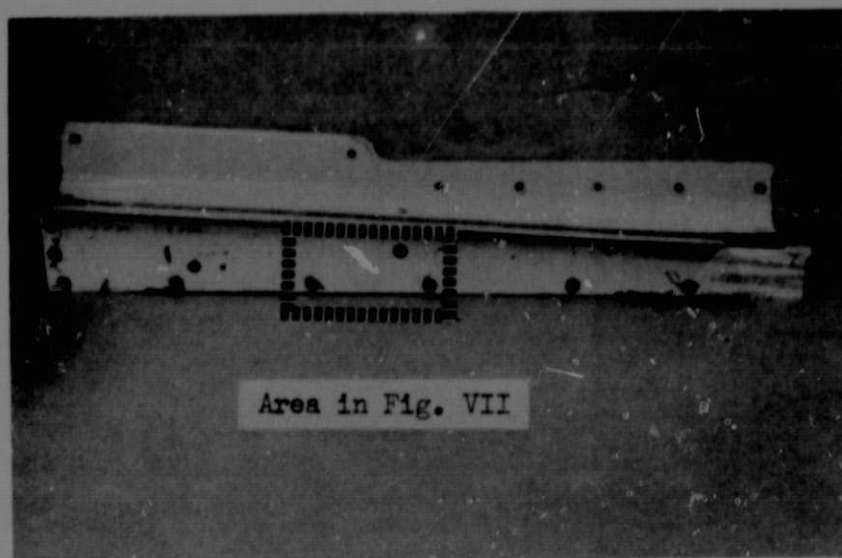


Figure VI Wing-Body Fillet with Elongated Holes

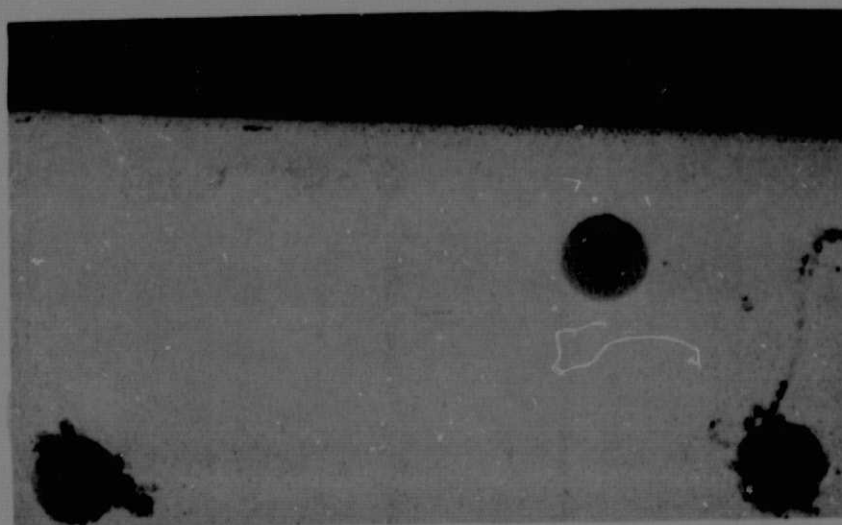


Figure VII Close-up of Wing-Body Fillet with Elongated Holes

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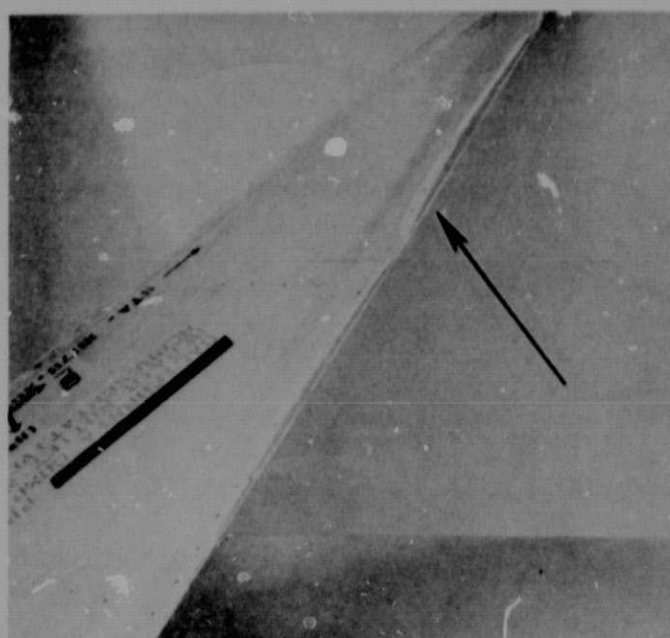


Figure VIII Delamination on Center Engine Fairing

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